AMERICAN NATIONAL STANDARD Z136.1 - 2000

Table 5b
Maximum Permissible Exposure (MPE) for Extended-Source Ocular Exposure to a Laser Beam for Long Exposure Durations[†]

Wavelength (μm)	Exposure Duration, t (s)	MPE ($J \cdot cm^{-2}$) except as noted	MPE ($W \cdot cm^{-2}$) except as noted	Notes
Visible				
0.400 to 0.700	10^{-13} to 10^{-11}	$1.5\,C_E \times 10^{-8}$		(See Tables 8 and 9
0.400 to 0.700	10^{-11} to 10^{-9}	$2.7\,C_E\,t^{0.75}$		for limiting apertures)
0.400 to 0.700	10^{-9} to 18×10^{-6}	$5.0\,C_E \times 10^{-7}$		
0.400 to 0.700	18×10^{-6} to 0.7	$1.8\,C_E\,t^{0.75} \times 10^{-3}$		

	Dual Limits for 400 - 600 nm visible laser exposure for $t > 0.7$ s			
Photochemical				
	For $\alpha \leq 11$mrad, the MPE is expressed as irradiance and radiant exposure*			
0.400 to 0.600	0.7 to 100	$C_B \times 10^{-2}$		(See Tables 8 and 9 for
0.400 to 0.600	100 to 3×10^{4}		$C_B \times 10^{-4}$	limiting apertures)
	For $\alpha > 11$mrad, the MPE is expressed as radiance and integrated radiance*			
0.400 to 0.600	0.7 to 1×10^{4}	$100\,C_B$ J·cm^{-2}·sr^{-1}		(See Table 8 for
0.400 to 0.600	1×10^{4} to 3×10^{4}		$C_B \times 10^{-2}$ W·cm^{-2}·sr^{-1}	limiting cone angle γ)
and				
Thermal				
0.400 to 0.700	0.7 to T_2	$1.8\,C_E\,t^{0.75} \times 10^{-3}$		
0.400 to 0.700	T_2 to 3×10^{4}		$1.8\,C_E\,T_2^{-0.25} \times 10^{-3}$	

Near Infrared				
0.700 to 1.050	10^{-13} to 10^{-11}	$1.5\,C_A\,C_E \times 10^{-8}$		(See Tables 8 and 9
0.700 to 1.050	10^{-11} to 10^{-9}	$2.7\,C_A\,C_E\,t^{0.75}$		for limiting apertures)
0.700 to 1.050	10^{-9} to 18×10^{-6}	$5.0\,C_A\,C_E \times 10^{-7}$		
0.700 to 1.050	18×10^{-6} to T_2	$1.8\,C_A\,C_E\,t^{0.75} \times 10^{-3}$		
0.700 to 1.050	T_2 to 3×10^{4}		$1.8\,C_A\,C_E\,T_2^{-0.25} \times 10^{-3}$	
1.050 to 1.400	10^{-13} to 10^{-11}	$1.5\,C_C\,C_E \times 10^{-7}$		
1.050 to 1.400	10^{-11} to 10^{-9}	$27.0\,C_C\,C_E\,t^{0.75}$		
1.050 to 1.400	10^{-9} to 50×10^{-6}	$5.0\,C_C\,C_E \times 10^{-6}$		
1.050 to 1.400	50×10^{-6} to T_2	$9.0\,C_C\,C_E\,t^{0.75} \times 10^{-3}$		
1.050 to 1.400	T_2 to 3×10^{4}		$9.0\,C_C\,C_E\,T_2^{-0.25} \times 10^{-3}$	

[†]See Table 6 and Figures 8, 9 and 11 for correction factors C_A, C_B, C_C, C_E, C_P, and time T_2.

*For sources subtending an angle greater than 11 mrad, the limit may also be expressed as an integrated radiance $L_p = 100\,C_B$ J·cm^{-2}·sr^{-1} for 0.7 s $\leq t < 10^{4}$ s and $L_w = C_B \times 10^{-2}$ W·cm^{-2}·sr^{-1} for $t \geq 10^{4}$ s as measured through a limiting cone angle γ. These correspond to values of J·cm^{-2} for 10 s $\leq t < 100$ s and W·cm^{-2} for $t \geq 100$ s as measured through a limiting cone angle γ.

   γ = 11 mrad for 0.7 s $\leq t < 100$ s,
   γ = $1.1 \times t^{0.5}$ mrad for 100 s $\leq t < 10^{4}$ s
   γ = 110 mrad for 10^{4} s $\leq t < 3 \times 10^{4}$ s

See Figure 3 for γ and Appendix B7.2 for examples.

Notes:
   1. For repeated (pulsed) exposures, see Section 8.2.3.
   2. The wavelength region λ_1 to λ_2 means $\lambda_1 \leq \lambda < \lambda_2$, e.g., 1.180 to 1.302 μm means $1.180 \leq \lambda < 1.302$ μm.
   3. Dual Limit Application: In the Dual Limit wavelength region (0.400 to 0.600 μm), the exposure limit is the lower value of the determined photochemical and thermal exposure limit.

APPENDIX 2